CLEAN VERSION OF CLAIMS

CLAIMS

1. An apparatus adapted for seismic data acquisition in a land or transition zone environment, said apparatus comprising:
a positioning device;
a seismic sensor, capable of being placed near said positioning device; and
means for determining the distance between said seismic sensor and said positioning device using an airborne acoustic transmission between said positioning device and said seismic sensor.

2. An apparatus as claimed in claim 1, in which said airborne acoustic transmission is produced by a speaker at said positioning device and received by a microphone at said seismic sensor.

3. An apparatus as claimed in claim 2, in which said airborne acoustic transmission received by said microphone at said seismic sensor is converted from analog to digital format using an analog to digital converter that is also used to convert seismic signals received by said seismic sensor from analog to digital format.

4. An apparatus as claimed in either claim 2 or claim 3, in which said airborne acoustic transmission received by said microphone at said seismic sensor is transmitted using a cable that is also used to transmit seismic data received by said seismic sensor.

5. An apparatus as claimed in any one of claims 1 to 4, in which said airborne acoustic transmission is a spread spectrum acoustic signal.

6. An apparatus as claimed in any one of claims 1 to 5, in which said airborne acoustic transmission is a pulse, frequency sweep, or digitally encoded sweep acoustic signal.

7. An apparatus as claimed in any one of claims 1 to 6, in which said airborne acoustic transmission is generated by signal generation circuitry that is also used to test said seismic sensor.

8. An apparatus as claimed in any one of claims 1 to 7, further including a temperature sensor for measuring the temperature of the air near said seismic sensor or said positioning device.

9. An apparatus as claimed in any one of claims 1 to 8, further including a survey flag and wherein said positioning device is placed near said survey flag.

10. An apparatus as claimed in any one of claims 1 to 9, in which said positioning device is a first positioning device and further including a second positioning device and means for determining the distance between said second positioning device and said seismic sensor using an airborne acoustic transmission between said second positioning device and said seismic sensor.

11. An apparatus as claimed in claim 10, further including means for determining the distance between said first positioning device and said second positioning device.

12. An apparatus as claimed in claim 11, in which said means for determining the distance between said first positioning device and said second positioning device uses an airborne acoustic transmission between said first positioning device and said second positioning device.

13. An apparatus as claimed in any one of claims 10 to 12, in which said first positioning device and said second positioning device are connected by a cable.

14. An apparatus as claimed in any one of claims 10 to 13, in which said second positioning device is placed at a predetermined azimuthal orientation with respect to said first positioning device.

15. An apparatus as claimed in any one of claims 10 to 14, further including means for confirming that said second positioning device has been placed at a predetermined azimuthal orientation with respect to said first positioning device.

16. An apparatus as claimed in any one of claims 10 to 15, in which a seismic source signal is used to determine to resolve the line symmetry ambiguity when determining the position of said seismic sensor with respect to said first positioning device and said second positioning device.

17. An apparatus as claimed in claim any one of claims 1 to 16, wherein said seismic sensor is a first seismic sensor and further including additional seismic sensors and means for determining the distance between said additional seismic sensors and said positioning device using airborne acoustic transmission between said positioning device and said additional seismic sensors.

18. An apparatus as claimed in claim 17, further including means for calculating a group center of gravity for said first seismic sensor and said additional seismic sensors.

19. An apparatus as claimed in claim 17, further including means for determining whether said first seismic sensor and said additional seismic sensors have been laid out in a prescribed order.

20. An apparatus as claimed in any one of claims 1 to 19, in which said seismic sensor and said positioning device are located at a first seismic station and further including an additional positioning device located at a second seismic station and means for determining the distance between a device located at said first seismic station and a device located at said second seismic station.

21. A method of determining the position of a seismic sensor adapted for seismic data acquisition in a land or transition zone environment, said method comprising the steps of:

placing a positioning device in a particular location;

placing a seismic sensor near said positioning device; and

determining the distance between said seismic sensor and said positioning device using an airborne acoustic transmission between said positioning device and said seismic sensor.

22. A method as claimed in claim 21, in which said airborne acoustic transmission is produced by a speaker at said positioning device and received by a microphone at said seismic sensor.

23. A method as claimed in claim 22, in which said airborne acoustic transmission received by said microphone at said seismic sensor is converted from analog to digital format using an analog to digital converter that is also used to convert seismic signals received by said seismic sensor from analog to digital format.

24. A method as claimed in either claim 22 or claim 23, in which said airborne acoustic transmission received by said microphone at said seismic sensor is transmitted using a cable that is also used to transmit seismic data received by said seismic sensor.

25. A method as claimed in any one of claims 21 to 24, in which said airborne acoustic transmission is a spread spectrum acoustic signal.

26. A method as claimed in any one of claims 21 to 25, in which said airborne acoustic transmission is a pulse, frequency sweep, or digitally encoded sweep acoustic signal.

27. A method as claimed in any one of claims 21 to 26, in which said airborne acoustic transmission is generated by signal generation circuitry that is also used to test said seismic sensor.

28. A method as claimed in any one of claims 21 to 27, further including the step of measuring the temperature of the air near said seismic sensor or said positioning device.

29. A method as claimed in any one of claims 21 to 28, in which said positioning device is placed near a survey flag.

30. A method as claimed in any one of claims 21 to 29, in which said positioning device is a first positioning device and further including the step of determining the distance between a second positioning device and said seismic sensor using an airborne acoustic transmission between said second positioning device and said seismic sensor.

31. A method as claimed in claim 30, further including the step of determining the distance between said first positioning device and said second positioning device.

32. A method as claimed in claim 31, in which said step of determining the distance between said first positioning device and said second positioning device uses an airborne acoustic transmission between said first positioning device and said second positioning device.

33. A method as claimed in any one of claims 30 to 32, in which said first positioning device and said second positioning device are connected by a cable.

34. A method as claimed in any one of claims 30 to 33, in which said second positioning device is placed at a predetermined azimuthal orientation with respect to said first positioning device.

35. A method as claimed in any one of claims 30 to 34, further including the step of confirming that said second positioning device has been placed at a predetermined azimuthal orientation with respect to said first positioning device.

36. A method as claimed in any one of claims 30 to 35, in which a seismic source signal is used to determine to resolve the line symmetry ambiguity when determining the position of said seismic sensor with respect to said first positioning device and said second positioning device.

37. A method as claimed in any one of claims 21 to 35, wherein said seismic sensor is a first seismic sensor and further including additional seismic sensors and the step of determining the distance between said additional seismic sensors and said positioning device using airborne acoustic

transmissions between said positioning device and said additional seismic sensors.

38. A method as claimed in claim 37, further including the step of calculating a group center of gravity for said first seismic sensor and said additional seismic sensors.

39. A method as claimed in claim 37, further including the step of determining whether said first seismic sensor and said additional seismic sensors have been laid out in a prescribed order.

40. A method as claimed in any one of claims 21 to 39, in which said seismic sensor and said positioning device are located at a first seismic station and further including an additional positioning device located at a second seismic station and the step of determining the distance between a device located at said first seismic station and a device located at said second seismic station.

41. A method as claimed in any one of claims 21 to 40, further including the steps of recording seismic data acquired by said seismic sensor and assigning sensor position coordinates to said seismic data based on said distance between said seismic sensor and said positioning device.

42. A method as claimed in any one of claims 21 to 41, further including the step of calculating a deviation between actual seismic sensor position coordinates and planned seismic sensor position coordinates.

43. A method as claimed in claim 42, further including the step of compensating for said deviation between said actual seismic sensor position coordinates and said planned seismic sensor position coordinates.

44. A method as claimed in claim 43, in which said compensation step includes mathematically moving a group center of gravity from an actual position to a planned position.

45. A method as claimed in claim 44, in which said compensation step includes bypassing a digital ground roll removal process.